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(54) Fluid pressure regulator

(57) A fluid pressure regulator e.g. for use in a domestic gas meter installation, has a housing 10 with inlet 12 and outlet 14 for fluid whose pressure is to be regulated. A main flow passage including upstream and downstream regions 26 and 28 extends between the inlet 12 and outlet 14. A main valve 34 having a main valve member 40 connected with a main diaphragm 36 is disposed between the upstream passage region 26 and the downstream passage region 28. A by-pass passage having an upstream region 52 and a downstream region 54 by-passes the main valve. A pilot valve 60 and a venturi 70 are disposed in the by-pass passage. A further passage 72 opens into a constricted region of the venturi 70 and communicates with a chamber 38 in which the main diaphragm 36 is disposed. The pilot valve 60 is responsive to fluid pressure at the outlet 14 so as to control the rate of flow of fluid through the venturi 70 and thereby the pressure in the further passage 72 so as to control flexing of the main diaphragm 36 in a manner to maintain a substantially constant outlet pressure.

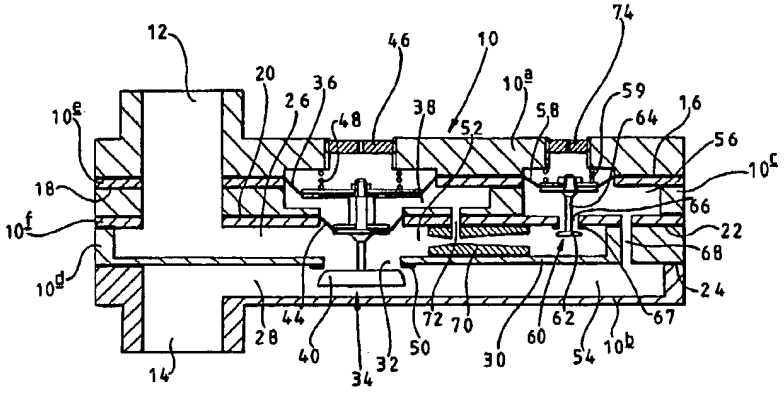

FIG 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

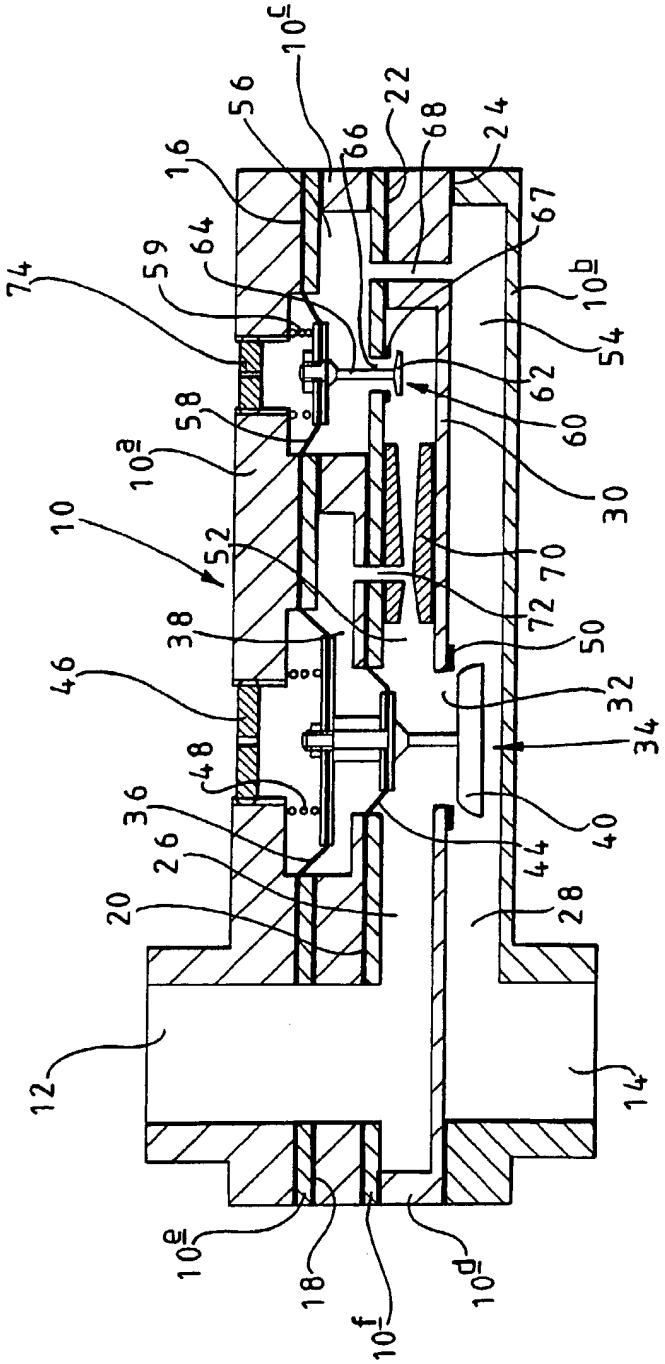
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FIG 1

FLUID PRESSURE REGULATOR

This invention relates to a fluid pressure regulator and is particularly, but not exclusively, concerned with a regulator for use in a domestic gas meter installation, particularly where a flow meter, a regulator and a meter control in the form of a manual control valve, and possibly also a thermal-cut off, are provided in a compact meter installation.

It is an object of the present invention to provide an improved fluid pressure regulator which can enable accurate pressure regulation.

According to the present invention, there is provided a fluid pressure regulator comprising (1) a housing having an inlet and an outlet for fluid whose pressure is to be regulated; (2) a main flow passage extending within the housing between the inlet and the outlet; (3) a main valve disposed within the housing, the main flow passage having an upstream region which extends between the inlet and the main valve and a downstream region which extends between the main valve and the outlet, and the main valve having (a) a flexible main diaphragm disposed in a main diaphragm chamber which is separated from the main flow passage and (b) a main valve member which mounted for movement with the main diaphragm and which is disposed within the main flow passage so that flexing of the main diaphragm in use causes variation of the effective fluid flow cross-section through the main valve; (4) a by-pass passage which by-passes the main valve; (5) a venturi disposed in the by-pass passage; (6) a further passage which opens into a constricted region of the venturi and which communicates with the main diaphragm chamber; and (7) pilot valve means in the by-pass passage downstream of the venturi, said pilot valve means being responsive to fluid pressure

at the outlet for controlling the rate of flow of fluid through the venturi and thereby the pressure in the further passage so as to control flexing of the main diaphragm in a manner to maintain a substantially constant outlet pressure.

By using a pilot valve in conjunction with a venturi in a by-pass passage to control the main diaphragm, an amplifying effect is achieved which enables the use of a smaller main diaphragm than in the case of a pilot-less system where the main diaphragm is used directly to sense outlet pressure. Since the pilot valve means is located in the by-pass passage (where a relatively low fluid flow exists), it is possible to use a relatively small size of pilot valve means. Also, it is possible for the main valve member to be of large cross-sectional area with the result that there is only a small pressure drop between the inlet and outlet when the main valve is open.

The pilot valve means preferably comprises a pilot valve disposed within the housing and having (a) a flexible pilot diaphragm acted upon by pressure in the by-pass passage and (b) a pilot valve member which mounted for movement with the pilot diaphragm and which is disposed within the by-pass passage so that flexing of the pilot diaphragm in use causes variation of the effective fluid flow cross-section through the pilot valve and thereby affects the flow rate through the venturi in use when fluid is flowing through the regulator.

Most preferably, the main and the pilot valves have respective main and pilot valve seats with which the respective main and pilot valve members are engageable to prevent flow through the main flow and by-pass flow passages, respectively, in circumstances where a positive fluid pressure

exists at the inlet of the regulator and there is no demand for fluid flow through the outlet.

In a preferred embodiment, the main and pilot diaphragms are defined by spaced locations on a common flexible sheet material.

Conveniently, the main and pilot valves are mounted in side-by-side spaced apart relationship within the housing with the venturi disposed between said valves.

In a particularly compact arrangement, the housing has an internal dividing wall which separates the upstream and downstream regions of the main flow passage and which has an aperture with which the main valve member cooperates and relative to which the latter is movable to vary the effective fluid flow cross-section between the upstream and downstream regions.

In a particularly convenient embodiment, the same internal wall separates an upstream region of the by-pass passage from a downstream region of the latter. Advantageously, the by-pass passage includes an intermediate region defined by a pilot diaphragm chamber in the housing.

In a particularly convenient and compact arrangement, the main diaphragm chamber and the pilot diaphragm chamber are arranged in side-by-side spaced apart relationship on the opposite side of the upstream regions of the main flow and by-pass passages to the downstream regions of such passages.

Conveniently also, the main valve member extends through a seal provided by a flexible sheet which serves to separate the main diaphragm chamber from the upstream region of the main flow passage. This provides a low friction seal.

The fluid pressure regulator according to the present invention is most preferably constructed and adapted to be used as part of a domestic gas meter installation.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawing which is a longitudinal section through a pressure regulator for use in a domestic gas meter installation.

Referring to the drawing, the pressure regulator is designed to provide a constant gas pressure irrespective (within the design limits of the installation) of the demand for gas from various appliances within the home and is also designed to provide total shut-off in circumstances where there is no demand for gas within the home and where there is a pressurised supply of gas to the regulator.

The regulator comprises a housing 10 having an inlet 12 for supply of pressurized gas from outside the home and an outlet 14 which is connected to various gas-burning appliances within the home, in use. In this embodiment, the inlet 12 and outlet 14 are coaxially arranged at one end of top and bottom faces, respectively, of the housing 10. The housing 10 comprises upper and lower housing parts 10a and 10b in which the inlet 12 and outlet 14 are respectively provided, and upper and lower intermediate housing parts 10c and 10d. The housing parts

10a to 10d are each moulded out of a suitable synthetic resin material. The housing 10 further includes plate-like housing parts 10e and 10f. Housing part 10e is disposed between the housing parts 10a and 10c, there being a sheet 16 of suitably elastomeric diaphragm material trapped between the parts 10a and 10e. Such sheet 16 serves to provide a seal between parts 10a and 10e but is appertured in the region of the inlet 12. A sealing gasket 18 is provided between those regions of parts 10c and 10e which are in mutual abutment.

A suitable flexible sealing sheet 20 is provided between parts 10c and 10f, whilst respective gaskets 22 and 24 are provided above and below part 10d to seal the latter relative to parts 10f and 10b, respectively. The various housing parts 10a to 10f are secured together by mechanical fixings.

The housing 10 has a main flow passage extending between the inlet 12 and the outlet 14, such main flow passage including an upstream region 26 defined mainly by part of a recess in housing part 10d, and a downstream region 28 defined mainly by part of a recess in housing part 10b. The housing 10 has an internal wall 30. The wall 30 has a circular aperture 32 therethrough which provides communication between the upstream and downstream regions 26 and 28 of the main flow passage.

The regulator further comprises a main valve 34 having a flexible main diaphragm 36 defined by that part of the sheet 16 which is exposed within a main diaphragm chamber 38 defined by housing parts 10a, 10c and 10e. The main valve 34 also has a main valve member 40 including a valve stem 42 which is secured to the main diaphragm 36 so that the valve member 40 is movable with the diaphragm 36. As can be seen

from the drawing, the main diaphragm chamber 38 is disposed on the opposite side of the upstream region 26 of the main flow passage to the downstream region 28. The housing parts 10c and 10f are apertured to allow passage of the valve stem 42, whilst the main diaphragm chamber 38 is sealed from the upstream region 26 by means of seal 44 which sealingly engages the valve stem 42 and which is defined by that part of the sheet 20 which is exposed in the apertured regions of the housing parts 10c and 10f. The rear face of the main diaphragm 36, i.e., that face which is presented away from the valve member 40, is vented to atmosphere via vent plug 46. A light compression spring 48 serves to urge the diaphragm 36 downwardly, i.e., in a direction to urge the main valve member 40 away from an annular main valve seat 50 surrounding the aperture 32.

The regulator further includes a by-pass passage which by-passes the main valve 34 and which includes an upstream region 52 defined between the housing parts 10d and 10f and by a portion of the same recess in housing part 10d which defines the upstream region 26 of the main flow passage. The by-pass passage further includes a downstream region 54 defined by a portion of the same recess in the housing part 10b which defines the downstream region 28 of the main flow control passage. The by-pass passage further includes an intermediate region defined by a pilot diaphragm chamber 56. The pilot diaphragm chamber 56 is defined by housing parts 10a, 10c, 10e and 10f, and houses pilot diaphragm 58 which forms part of a pilot valve 60. The pilot diaphragm 58 is formed by a part of the same sheet 16 which defines the main diaphragm 36. The diaphragms 36 and 58 are disposed in side-by-side spaced apart relationship, like the main and pilot diaphragm chambers 38 and 56. The pilot valve 60 includes a pilot valve member 62

including a valve stem 64 which is secured to the diaphragm 58. The pilot valve member 60 is disposed in the upstream region 52 of the by-pass passage, whilst the valve stem 64 passes through an aperture 66 in housing part 10f, the aperture 66 providing communication between the upstream region 52 and the pilot diaphragm chamber 56 defining the intermediate region of the by-pass passage.

The pilot diaphragm chamber 56 communicates with the downstream region 54 of the by-pass passage via a hole 68 provided through the housing parts 10f and 10d. In this way, the chamber 56 is always in communication with the outlet 14.

The regulator additionally comprises a venturi 70 which is disposed in the upstream region 52 of the by-pass passage immediately upstream of the pilot valve member 62. A further passage 72 opens into the constricted region of the venturi 70 and extends at right angles thereto so as to open into the main diaphragm chamber 38.

The pilot valve member 62 cooperates with a pilot valve seat 67 surrounding the aperture 66. The pilot diaphragm 58 is urged by a light compression spring 59 in a direction tending to urge the pilot valve member 62 away from the pilot valve seat 67. The compression spring 59 also serves to facilitate setting-up of the regulator during manufacture. The rear of the pilot diaphragm 58 is vented to atmosphere via vent plug 74.

As will be apparent from the above and from the drawing, the diaphragm chamber 38 and 56 are disposed on the opposite side of the upstream regions 26 and 52 of the main and by-pass passages to the downstream

regions 28 and 54 of the latter. The upstream portions 26 and 52 extend in the same direction and generally parallel to the direction of extent of the downstream regions 28 and 54, and are defined mainly by the same recess in housing part 10d. Likewise, the downstream regions 28 and 54 are defined mainly by the same recess in the housing part 10b. Such regions 26, 28, 52 and 54 extend perpendicularly with respect to the axes of the inlet 12 and outlet 14 and with respect to the direction of movement of the valve members 40 and 62.

In use, inlet 12 is connected to a relatively low pressure (23 - 75 mbar gauge) , whilst the outlet 14 is connected to the gas-burning appliances in the home. When none of the appliances is using any gas, pressure builds up at the outlet, causing pressure under the pilot diaphragm 58 to increase and thereby to close the pilot valve member 62 against its seat 67. This causes flow through the venturi 70 to cease so that the pressure under the main diaphragm 36 increases to inlet pressure, closing the main valve member 40 against its seat 50. When a gas valve on one or more of the appliances in the home is opened, the resultant pressure drop is transmitted via outlet 14, downstream regions 28 and 54 and hole 68 to the pilot diaphragm chamber 56. This immediately causes the pilot diaphragm 58 to flex downwardly as viewed in the drawing, thus opening the pilot valve member 62 away from its seat 67. Thus, gas from the inlet 12 can flow along upstream regions 36 and 52, through the venturi 70 and into the diaphragm chamber 56. The flow of gas through the venturi 70 causes a pressure drop to be established in passage 72 and thereby a pressure drop in the main diaphragm chamber 38. The net result of this is to cause the main diaphragm 36 to flex downwardly as viewed in the drawing to open the main valve member 40, thereby establishing a direct gas flow between the upstream and

downstream regions 26 and 28 of the main flow passage. It will be appreciated that the amount by which the main diaphragm 36 flexes downwardly depends upon the reduction in pressure which occurs in passage 72 which in turn depends upon the rate of gas flow through the venturi 70. Thus, it will be appreciated that an equilibrium is established so as to produce a substantially constant pressure at the outlet 14 irrespective of the demand for gas from the appliances in the home (within the design limits of the installation).

In a modification (not shown) a remotely operable shut-off valve is provided for shutting off gas flow between the venturi 70 and the downstream region 54. When this valve is operated, there is no flow through the venturi 70 and so the gas pressure on the inlet side of the regulator causes the diaphragm 36 to flex upwardly so as to close the main valve member 40 against its seat 50. Hence, the application of a pressure equal to inlet pressure under the main diaphragm 36 causes the main valve member 40 to close on its seat 50. The remotely operable valve may be a needle valve operated by an electrically controlled coil when, for example, the gas authorities wish to cut-off the gas supply to the home. Alternatively, such valve may be operated automatically in the event of failure of an electrical power supply within the meter or can be controlled remotely to stop or re-instate the flow through the regulator. For example, it is envisaged that the gas meter itself may be of a type requiring a power supply, preferably in the form of a storage battery. Thus, the arrangement may be such that, in the case of unauthorised battery removal, the regulator will close down and prevent gas from being supplied when the gas meter itself is inoperative.

When the remotely operable shut-off valve is operated (i.e. passage 68 is blocked), an alternative internal valve and diaphragm arrangement can be included to prevent the main valve member 40 opening when there is no pressure at the inlet 12.

CLAIMS

1. A fluid pressure regulator comprising (1) a housing having an inlet and an outlet for fluid whose pressure is to be regulated; (2) a main flow passage extending within the housing between the inlet and the outlet; (3) a main valve disposed within the housing, the main flow passage having an upstream region which extends between the inlet and the main valve and a downstream region which extends between the main valve and the outlet, and the main valve having (a) a flexible main diaphragm disposed in a main diaphragm chamber which is separated from the main flow passage and (b) a main valve member which mounted for movement with the main diaphragm and which is disposed within the main flow passage so that flexing of the main diaphragm in use causes variation of the effective fluid flow cross-section through the main valve; (4) a by-pass passage which by-passes the main valve; (5) a venturi disposed in the by-pass passage; (6) a further passage which opens into a constricted region of the venturi and which communicates with the main diaphragm chamber; and (7) pilot valve means in the by-pass passage downstream of the venturi, said pilot valve means being responsive to fluid pressure at the outlet for controlling the rate of flow of fluid through the venturi and thereby the pressure in the further passage so as to control flexing of the main diaphragm in a manner to maintain a substantially constant outlet pressure.

2. A regulator as claimed in claim 1, wherein the pilot valve means comprises a pilot valve disposed within the housing and having (a) a flexible pilot diaphragm acted upon by pressure in the by-pass passage and (b) a pilot valve member which mounted for movement with

the pilot diaphragm and which is disposed within the by-pass passage so that flexing of the pilot diaphragm in use causes variation of the effective fluid flow cross-section through the pilot valve and thereby affects the flow rate through the venturi in use when fluid is flowing through the regulator.

3. A regulator as claimed in claim 2, wherein the main and the pilot valves have respective main and pilot valve seats with which the respective main and pilot valve members are engageable to prevent flow through the main flow and by-pass flow passages, respectively, in circumstances where a positive fluid pressure exists at the inlet of the regulator and there is no demand for fluid flow through the outlet.

4. A regulator as claimed in claim 2 or 3, wherein the main and pilot diaphragms are defined by spaced locations on a common flexible sheet material.

5. A regulator as claimed in any one of claims 2 or 4, wherein the main and pilot valves are mounted in side-by-side spaced apart relationship within the housing with the venturi disposed between said valves.

6. A regulator as claimed in any preceding claim, wherein the housing has an internal dividing wall which separates the upstream and downstream regions of the main flow passage and which has an aperture with which the main valve member cooperates and relative to which the latter is movable to vary the effective fluid flow cross-section between the upstream and downstream regions.

7. A regulator as claimed in claim 6, wherein said internal dividing wall separates an upstream region of the by-pass passage from a downstream region of the latter.

8. A regulator as claimed in any preceding claim, wherein the by-pass passage includes an intermediate region defined by a pilot diaphragm chamber in the housing.

9. A regulator as claimed in claim 8, wherein the main diaphragm chamber and the pilot diaphragm chamber are arranged in side-by-side spaced apart relationship on the opposite side of the upstream regions of the main flow and by-pass passages to the downstream regions of such passages.

10. A regulator as claimed in any preceding claim, wherein the main valve member extends through a seal provided by a flexible sheet which serves to separate the main diaphragm chamber from the upstream region of the main flow passage.

11. A regulator as claimed in claim 1, substantially as hereinbefore described with reference to the accompanying drawing.

12. A gas meter installation including a fluid pressure regulator as claimed in any preceding claim.

The Patent Office

Application No: GB 9420942.6 **Examiner:** R C Squire
Claims searched: 1 to 12 **Date of search:** 8 March 1995

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.N): G3P (PSAP,PSCP,PEX)

Int Cl (Ed.6): G05D

Other: Online database:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2246615A	British Gas	1
X	GB0524896	Donkin	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.